Theory Program Overview

Stephen Eckstrand

OFES Budget Planning Meeting

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Theory Program Goal

Office of Fusion Energy Sciences

- **Achieve a predictive scientific understanding of the behavior of high temperature plasmas**
  - **Acquire new, improved analytic and computational capabilities in order to make improved comparisons between analytic theory, simulations, and experiments**
  - **Provide the critical theoretical effort needed to understand present experiments and suggest new operating regimes or approaches to improve performance**
  - **Develop an integrated capability to predict the performance of future experimental devices**

Research Performers

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- **The theory program is composed of research performers at national labs, universities, and industry**
- **The program has both large and small groups and individual investigators**
  - **Seven groups with annual funding of $1M or more**
  - **Four groups with annual funding of $0.5 - $1.0M**
  - **Approximately 30 additional grants ranging from $50K to $500K**
- **Theory program funding supports about 100 FTEs (including post docs)**

Major Accomplishments

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- **Analytic theory, which is essentially independent of plasma models, has shown that marginally stable resistive wall modes can strongly damp toroidal plasma rotation, and that simple error field correction coils can prevent this damping.**
- **The All-Orders Spectral Algorithm has been extended to give fully 3D solutions of the integral wave equation for minority ion cyclotron heating in stellarator geometry. Combining multiple periodic solutions for individual helical field periods yields complete wave solutions valid over the entire volume of the stellarator for arbitrary antenna geometry.**
- **Studies of transport scaling with respect to tokamak device size using gyrokinetic particle simulations of electrostatic ion temperature gradient (ITG) turbulence with adiabatic electrons show that the local transport coefficient exhibits a gradual transition from a Bohm-like scaling to a gyro-Bohm scaling.**

Funding by Type of Institution

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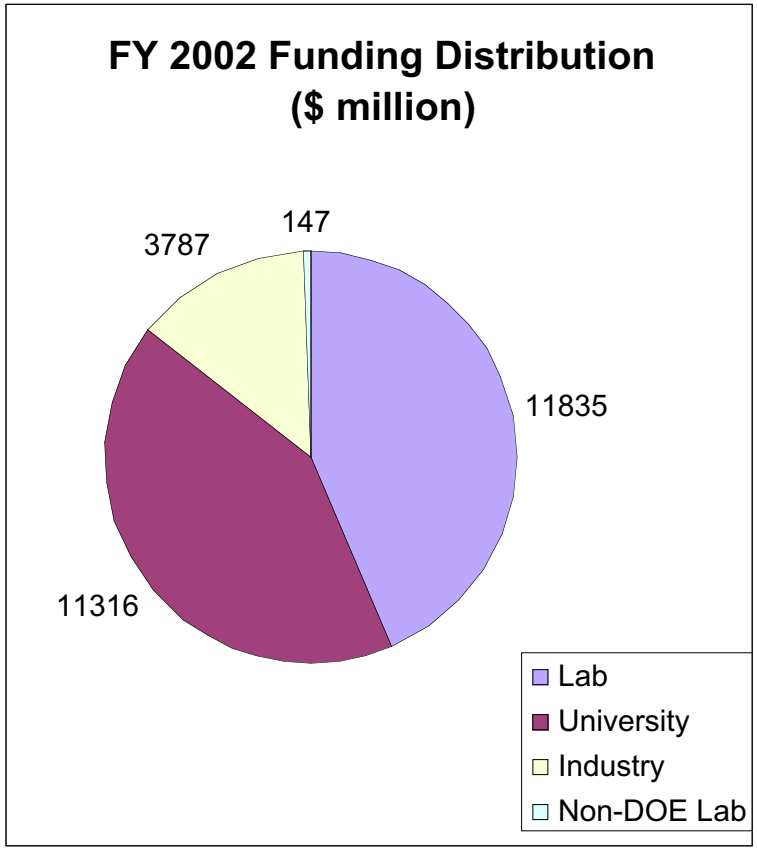
- **Funding is well balanced between laboratories, universities, and industry**
- **Funding at laboratories has been flat for many years**
- **Total funding for universities has also been flat, but some grants have been incremented based on peer review results**



Funding by Budget Category

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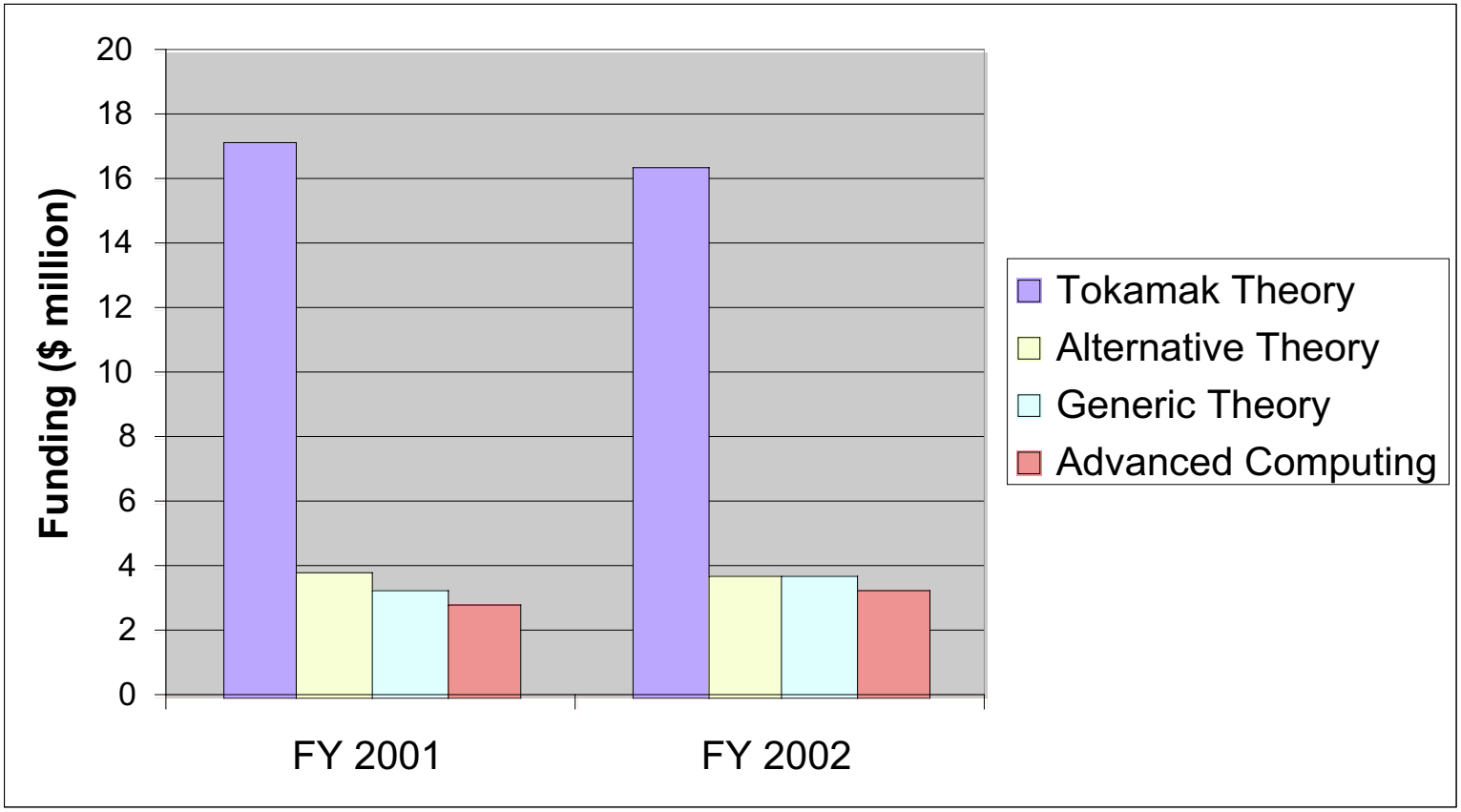

Funding by Scientific Topic

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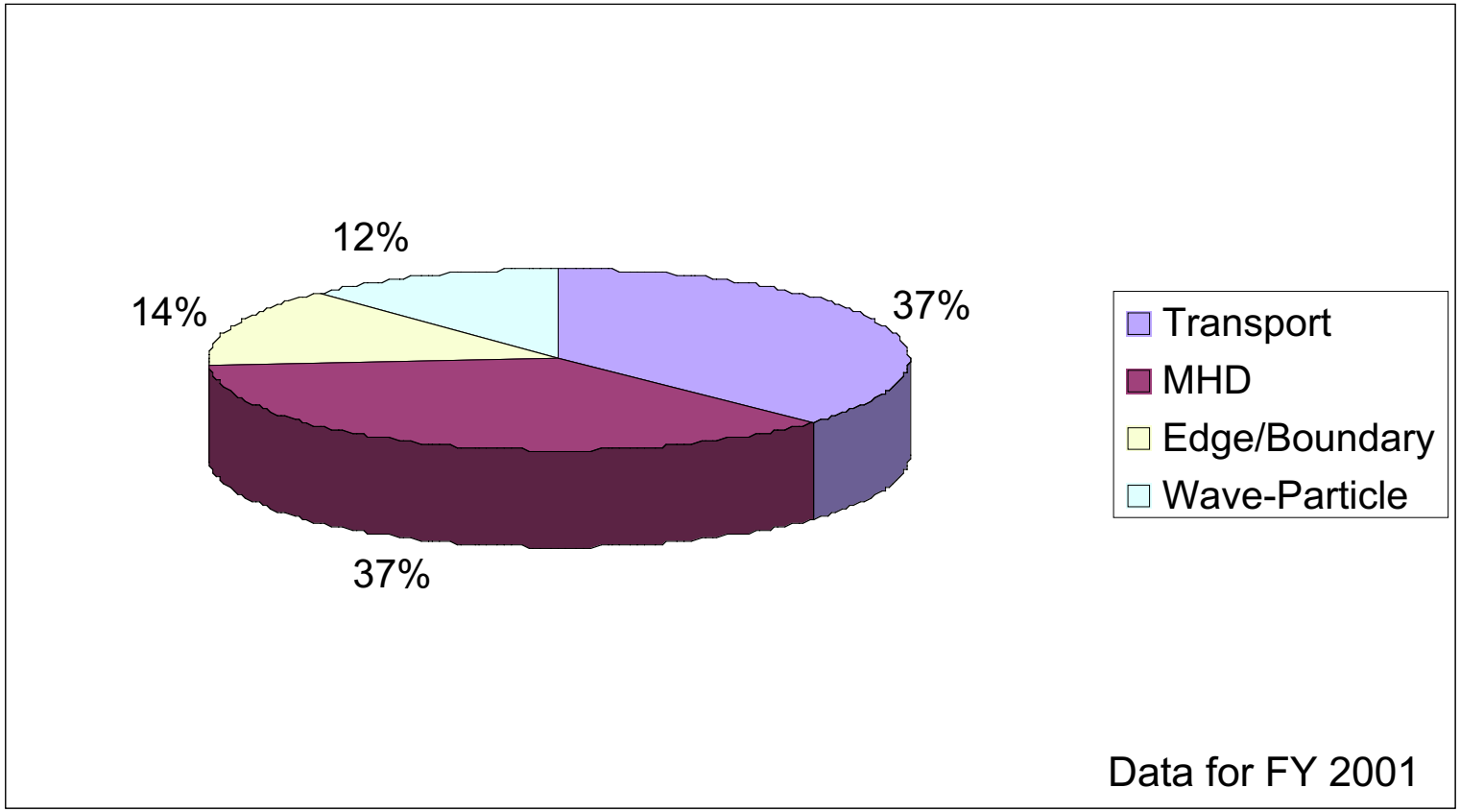

Program Management

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- Grant applications evaluated by the peer review process established in 2000 for FY 2001 grants
- Laboratory groups evaluated by mail reviews, with larger groups also reviewed by on-site panels
- In all cases funding decisions are based on both the recommendations of the peer reviewers and the programmatic needs

Results of Grant Review Process

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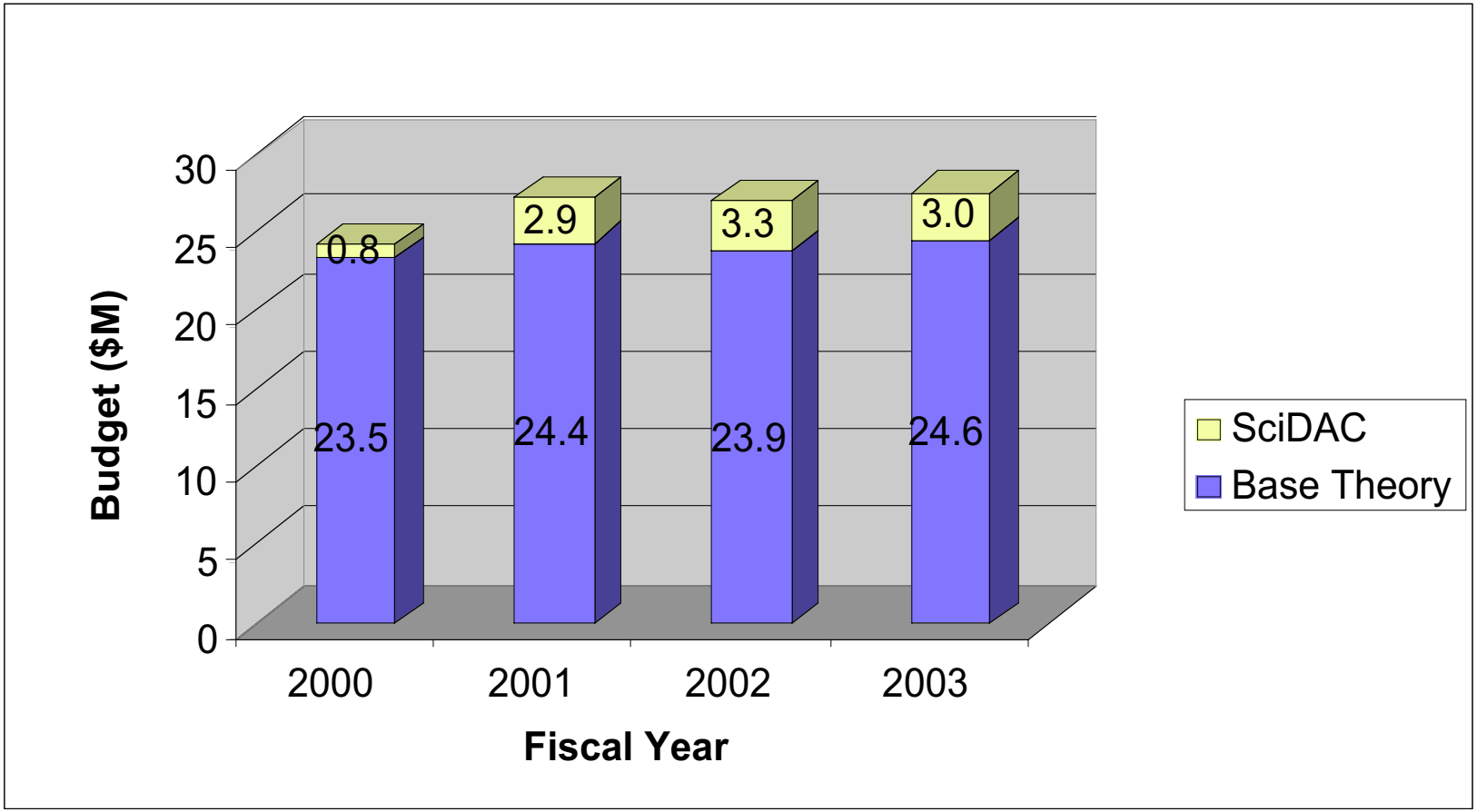
- **FY 2001**
  - 23 applications received
  - 11 grants funded (including 2 new)
  - 12 applications declined
  - 4 worthy applications could not be funded
- **FY 2002**
  - 48 applications received
  - 10 grants funded (including 1 new)
  - 38 applications declined (including 3 renewals)
  - 15 worthy applications could not be funded

Theory Budget History

Office of Fusion Energy Sciences



Theory Program Issues

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- **Flat funding in the base theory program has resulted in an erosion of effort of about 5% per year**
- **Theory support for advanced tokamaks is adequate, at best, while support for innovative concepts is clearly inadequate**
- **Without additional funding theory support for the stellarator program will also be inadequate**

Budget Variations

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- **Results of a ten percent decrement**
  - **Decrease theory manpower by about 15%; exact distribution would depend on what cuts were made in the remainder of the program**
- **Incremental funding priorities**
  - **Innovative concepts (+$2 M)**
  - **Stellarator program (+$1.5 M)**
  - **A few areas of advanced tokamak theory (e.g. edge/pedestal region theory) and ST theory (+$1.5 M)**
  - **Integrated Modeling**

FESAC Theory Panel Recommendations

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- The T/C program should be focused on achievement of the FESAC goals through T/C community and Theory Coordinating Committee input to an updated Integrated Program Planning Activity (IPPA) report. Also, a vision statement and regularly updated list of key issues and challenges should be published.
- The Theory Coordinating Committee could respond to specific charges from OFES or call to the attention of OFES, FESAC, and the T/C community overarching issues that require timely resolution.

FESAC Theory Panel Recommendations

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- A systematic approach to providing theory and computing support should be developed for experiments and design studies, and should be considered in the review of proposals.
- Multi-user code projects should be initiated only on the basis of compelling usefulness, but then should receive adequate support.
- Code duplication should be minimized …
- OFES should develop an understanding of how the T/C needs of a particular program are to be met, and of the responsibilities for leadership and support of the various institutions involved (e.g., by means of memoranda of understanding, program advisory committees etc).

Suggested Actions

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- **The TCC should set up subcommittees of 3-4 people who would prepare short white papers on theory needs and opportunities in each of the major topical areas of plasma/fusion research; the subcommittees should consider the IPPA goals and experimental needs in preparing these white papers.**
- **In order to adequately reflect the needs of the advanced tokamak, spherical torus, stellarator, RFP, etc., it is also important to develop integrated plans to support each of the larger experimental programs.**

Approach to Planning

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	Turbulence & Transport	Wave-Particle Int.	Magnetic Reconnection Stability	Sheaths & Boundary Layers
Advanced Tokamak	— — — — — — — — — →			
Spherical Torus	— — — — — — — — — →			
RFP	— — — — — — — — — →			
Stellarator	— — — — — — — — — →			